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## UNUSUAL WEATHER AT DODGE, KANS.

BY EUGENE D. EMIGH, Assistant Observer, Dodge, Kans.

Meteorological features of the most unusual characteristics have rendered exceptionally interesting the weather of the two weeks ending February 8, 1905. January 25, 26, and 27 were partly cloudy and pleasant, but throughout the next eight days the sky was entirely obscured, with the exception of two days when the sun shone dimly and for very short intervals.

Rainfall with the temperature below 32° F. is a rare phenomenon, and that rain should be observed at 13° F. seems an almost incredible occurrence, yet one conclusively demonstrated. Light, misting rain began during the night of January 29-30th, with the temperature in the neighborhood of 15° F., and though the highest temperature attained was 24° F. and a minimum of 13° F. occurred, yet precipitation in distinct liquid form was practically continuous for about forty-eight hours, 0.03 inch being recorded. Occasional light flurries of snow mingled with the mist and netted 0.01 inch of water.

Protracted periods of cloudy, unsettled, and stormy weather are not so infrequent as to be considered remarkable in this region; nor is the continuation of severe cold through several days or a week without numerous precedents. It is in the combination of these two conditions that the past week is unique in the 31 winters through which our records extend. Intensely cold weather succeeded the change of precipitation from rain to snow during the night of January 31-February 1. From 7 p. m. of February 1 to 11 a. m. of the 4th, the thermometric column remained below the zero mark, and it was not until Tuesday, the 7th, that no daily minimum temperature below zero, Fahrenheit, was recorded. Eleven degrees below zero on the morning of the 3d was the extreme minimum. Light snow was almost uninterrupted until the morning of the 5th, when a clear day intervened, but the snow resumed its fall on the evening of the 6th and did not finally cease until the morning of the 8th, 2.1 inches being the total snowfall from February 1.

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The interesting phenomenon to which Mr. Emigh calls our attention is intimately associated with the southward movement of a most remarkable area of high pressure and low temperature. This appeared in Canada on January 26 and by the morning of Saturday, the 28th, the isotherm of 20° F. had moved westward up the eastern slope, so as to extend continuously from near Barkerville, British Columbia, to Topeka, Kans., and agreed generally with a contour line of about 2000 feet or possibly 2500 feet above sea level. On the morning of the 29th this isotherm was pushed farther west and appeared along the contour line of 6000 feet in Wyoming, and of about 3000 feet west of Dodge. It is very rare that the cold air of the high areas on the eastern slope push up the slope as high as Cheyenne. North and east of Dodge cloudy weather with light snow prevailed on the 28th, 29th, and 30th. But above this cold region of snow, the layer of clouds must have represented a layer of air cooled slowly by radiation so that the fine liquid droplets forming the clouds were subcooled, that is to say cooled far below the temperature of freezing, while still retaining their liquid condition. This is a phenomenon that frequently occurs in nature, and can be easily reproduced in the laboratory. Observers in balloons have frequently recorded the occurrence of such small drops of water, which, on coming in contact

with any solid substance turn to crystals of ice and frost. Even larger raindrops often descend through the cold air and cover the limbs of plants and the ground with a layer of smooth ice, known as Glatteis to German meteorologists. We presume that this was the phenomenon recorded by Mr. Emigh.

If, however, he observed liquid precipitation amounting to 0.03 inches of water in forty-eight hours, and observed this to retain the form of water when measured in the rain gage, although the air temperature and that of the rain gage varied between 24° F. and 13° F., then this certainly is unprecedented.—*C. A.*

## STUDIES ON THE DIURNAL PERIODS IN THE LOWER STRATA OF THE ATMOSPHERE.

By Prof. FRANK HAGAR BIGELOW.

### I. THE DIURNAL PERIODS OF THE TEMPERATURE.

#### GENERAL REMARKS.

The following series of papers contains the results of a research into the periodic diurnal processes that take place in the strata of the atmosphere within two miles of the sea-level surface, as disclosed by the data derived from the balloon and kite ascensions made during the past ten years. It includes a discussion of the variations of the temperature, the pressure, the vapor tension, the atmospheric electric potential and coefficient of dissipation of the electric charge, and the diurnal periodic action of the magnetic force. These subjects have been under discussion by meteorologists for many years, but the issue has been so indecisive as to imply that certain important terms have been lacking in the problems, so that it was impossible to come to any definite view regarding the causes and effects in the physical processes. That all these diurnal periods depend upon the effects of the solar radiation in the earth's atmosphere has been evident, but the difficulty of matching together the various lines of experimental evidence derived from observations has been so great that no settled solution has seemed available. The additional data which have been recently secured through observations made in the free air above the ground have, however, altered the point of view in some respects, so that it is believed that the account to be given in these papers describes natural conditions more nearly than has heretofore been possible.

The immediate occasion for undertaking this research consists in the necessity of deciding upon the best lines of work for the Mount Weather Meteorological Observatory, at Bluemont, Va. The organization of so large an institution, dealing with problems in common meteorology, solar radiation, atmospheric electricity and magnetism, made it very important to acquire a clear idea of the relative values of the several types of observation, in order that suitable instruments might be installed and proper observations inaugurated. Since the effects of solar radiation involve many local characteristics which ought to be eliminated before the pure solar terms can be obtained, it was evident that some further knowledge of the diurnal verifications of the several elements should be secured if possible, at least to the extent of reconciling the conflicting evidence that the special lines of research have hitherto produced. It seemed the simplest course to make a study of the data furnished by kite and balloon ascensions, and for this purpose the observations at Berlin,[1] Trappes,[2] Hald,[3] and Blue Hill[4] have been studied.

In this paper our examples will be taken from the Blue Hill data as more applicable to the American meteorological field than the European data can be without special consideration. It should be noted that the Blue Hill Observatory furnished the Weather Bureau with certain temperature observations, made at the Valley Station, which were required in the proposed discussion, and for this courtesy our thanks are expressed.

#### METHOD OF REDUCING THE OBSERVATIONS.

In Volume XLIII, Part III, Annual Harvard College Observatory, Table III, pages 166–214, the data are given for the temperatures on Blue Hill summit, 195 meters, at various heights, and occasionally at the Valley Station, 15 meters, together with the hour and minute of the observation.

(1) The first step in this discussion was to concentrate this material into smaller proportions by taking the mean values where the kites soared at about the same elevation. This gave a new series of data for the time, height, temperature at that height, and temperature at the summit. Corresponding temperatures for the valley at these times were extracted from the observatory records, at the request of the Weather Bureau, so that it became possible to refer the temperature-falls practically to the sea level. It was feared that any characteristic effects of the Blue Hill itself upon the diurnal temperatures, by means of radiation or by convection currents, might prevent the computed temperatures at higher elevations from bringing out the law in the free air with sufficient purity.

(2) A computation of the temperature-fall was next made for each time of observation by taking the difference between the temperature at the height and the valley temperature. A discussion of these temperature differences was preferred, in order finally to obtain the mean temperature at certain selected levels for each hour in the day, rather than to mass together the actual temperature readings recorded at these levels. In the former case the numerical values are less scattering than in the latter, and therefore they are more easily reduced to mean values. If the actual temperatures of the air, in the successive masses associated with the progress of high or low areas over a given station, are employed as the basis of computation, a very large number of observations are required to produce correct normal values in the several strata. The mean temperature falls, on the other hand, added to the normal values at the Valley Station, give the same result theoretically, and this can be obtained much more exactly for a limited number of observations by the method of differences.

(3) The first collection of the temperature differences contained the data applicable by simple interpolation to the levels 15, 195, 400, 600, ..... 3800, 4000 meters, or as high as the ascension made its record. The data from the several years, 1897-1902, were collected by months, so that for example all of the January temperature-falls were brought together. They were also arranged by cyclonic and anticyclonic areas, so as to distinguish between the cold southward-directed current and the warm northward-directed current. The former covers generally the areas lying between the centers of the high and low to the eastward of the high, with winds from the northern quadrants, and the latter includes the areas between the centers of the low and high to the eastward of the low, with winds from the southern quadrants. Referring to the subareas adopted in my Cloud Report, chart 9, page 139, they were arranged in the following scheme, marked for convenience H. I=N.W., L. II=N.E., for southward, L. III=S.W., H. IV=S.E., for northward. The subarea for Blue Hill on the date of observation was scaled from the Weather Bureau daily weather maps.

The purpose of this collection was to discover to what extent the diurnal temperature-falls and corresponding gradients in the free air depend upon the cyclonic circulation, that is whether the temperature-fall is different over the cold currents from the north to that over the warm currents from the

[1] Wissenschaftlice Luftfahrten, 1888–1898, Berlin.

[2] Veröffentlichungen der Internationalen Kommission für wissenschaftliche Luftschiffahrt, 1901–3

[3] Travaux de la Station Franco-Scandinave de Sondages Aériens à Hald, 1902–3, L. T. de Bort.

[4] Observations at the Blue Hill Observatory, 1901-2, and appendix of the observations with kites 1897–1902, with discussion by H. Helm Clayton.